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DEFECT INVESTIGATION OF CARTRIDGE ILLUMINATING 1-1/2
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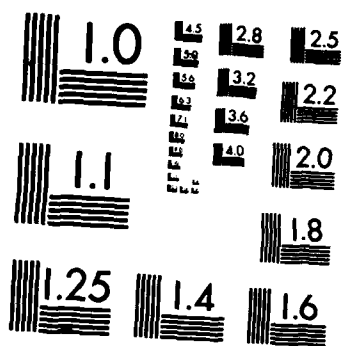
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ILLUMINATING 1-1/2 INCH

M.A. Wilson and R. Bird

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The bulging of metal ammunition boxes containing 1-1/2" illuminating Flare Cartridges has been investigated. The defect occurred during storage of flares manufactured in 1976-78 and was found to be due to the entry of moisture into the magnesium based flare composition resulting in the generation of hydrogen. The stores were so adversely affected that MRL recommended that they be destroyed.

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DEFECT INVESTIGATION OF CARTRIDGE

ILLUMINATING 1-1/2 INCH

1. INTRODUCTION

Navy requested MRL to investigate the bulging of metal ammunition boxes containing 1-1/2" illuminating flare cartridges. The cartridges, manufactured in the UK between 1976-78, had been stored both on Australian naval vessels and in storage magazines. MRL have examined some of the cartridges and found evidence of reaction between moisture and the magnesium in the pyrotechnic composition which would have resulted in the liberation of considerable quantities of hydrogen and ammonia gases.

2. BACKGROUND

The cartridge illuminating 1-1/2 inch J.Mark 4T (Fig. 1) contains pressed pellets of the flare composition SR 580 which was developed in 1937 at the Royal Armament Research and Development Establishment, Fort Halstead, UK. The composition contains 60 per cent magnesium powder, grade 4; 36 per cent sodium nitrate and 4 per cent acaroid resin. In order to reduce attack of the magnesium by moisture, the metal powder is coated with the resin from alcoholic solution, dried and then mixed with the oxidizer. The loose composition is pressed into a paper cylinder, the base of which is pre-coated with nitrocellulose varnish. The cartridge case is made of cardboard which is closed, after loading, with a millboard disc and shellac adhesive. The cartridges were manufactured at the Royal Ordnance Factory, Chorley, UK and have a recommended service life of five years from date of manufacture, subject to subsequent routine periodic inspection and proof. The cartridges are currently in service with the Royal Australian Navy and are normally stored in M19A1, and M2A1 boxes in lots of 10 and 20 respectively (Fig. 2). The free space in the boxes is packed with waxed paper to protect against vibration and rough handling. Both types of box incorporate a rubber gas seal in the lid.

3. DEFECT INVESTIGATION

The containers, which had bulged due to internal pressure, were considered unsafe for transport; therefore three cartridges from one of the two suspect lots (CY6/76 and CY8/78) were repackaged into an ammunition box and forwarded to MRL by the Inspector of Naval Ordnance, Naval Armament Depot, Newington, NSW for examination. Discussions with NQAR, Newington revealed that both types of ammunition box had been opened within the last 2 years and now exhibited severe bulging of the sides and bottoms of the boxes. In order to determine indirectly the internal pressure, an M2A1 box was pressurized with air until deformation was similar to that of an unopened box held at INO, Sydney (Fig. 3). It was found that an internal pressure of approximately 100 kPa was required to bulge the sides of the box to the 13 mm noted by INO. Pressures in excess of this figure cause temporary venting past the seal in the lid which therefore acts as a limiting valve. A pressure of 100 kPa exerts a force on the lid of a M2A1 ammunition box of almost 4 kN. Upon opening, the lid will be propelled back against the hinge with considerable violence.

It was not considered necessary to sample and identify the gas present in the container held at INO Sydney, as analysis of the pyrotechnic composition used in the cartridges would determine if a gas liberating reaction had taken place. Samples of the flare composition were taken from the cartridges and analyzed for free and total magnesium content.

TABLE 1

| <u>SR 580 Sample Source</u> | <u>Free Magnesium</u> | | <u>Total Magnesium</u> | |
|--------------------------------------------------------------------------|---------------------------------------------|-------|---------------------------------------------|-------|
| Cartridge illuminating 1-1/2" Lot 013 CY8/78 from centre of pellet | (i) | 46.7% | (i) | 59.4% |
| | (ii) | 47.0% | (ii) | 59.3% |
| | $\overline{\text{Mg}}_{\text{CF}} = 46.9\%$ | | $\overline{\text{Mg}}_{\text{CT}} = 59.4\%$ | |
| | | | | |
| Cartridge illuminating 1/12" Lot 013 CY8/78 from edge of pellet | (i) | 43.8% | (i) | 59.4% |
| | (ii) | 43.8% | (ii) | 59.3% |
| | (iii) | 42.2% | (iii) | 58.9% |
| | $\overline{\text{Mg}}_{\text{EF}} = 43.3\%$ | | $\overline{\text{Mg}}_{\text{ET}} = 59.2\%$ | |

The free magnesium content was determined by the eudiometric method and the total magnesium content by EDTA titration [1]. These results indicated that marked deterioration of the magnesium had occurred, a situation which would

seriously affect the serviceability of the stores. Calculations showed that to produce an overpressure of approximately 100 kPa in a M19A1 box containing 10 cartridges, about 1.6 gram of magnesium must react; this corresponds to a decrease in free magnesium content of less than 0.2%.

According to Cackett [2], magnesium reacts with water, especially in the presence of anions, to produce magnesium hydroxide and hydrogen gas according to the equation :



and each milligram of moisture present in a composition is capable of oxidizing 0.67 milligrams of magnesium and of liberating 62 millilitres of hydrogen. The gas evolved can exert dangerously high pressure in hermetically sealed stores or containers. In the presence of nitrates, secondary reactions lead to the formation of nitrites and ammonia, which would be present in varying amounts in the liberated gases. All compositions containing magnesium powder slowly deteriorate as moisture gains access to the metal. The rate of deterioration depends partly on the degree of protection afforded by the coating on the magnesium and partly on the nature of the other ingredients. Since both the sodium nitrate and acaroid resin used in SR 580 tend to be hygroscopic and each cartridge is fabricated using mainly paper and cardboard components, all of which contain moisture, the limited service life of this store is not surprising. The opening and subsequent re-sealing of the boxes containing the cartridges in a hot and humid environment would give rise to conditions which would accelerate the deterioration of this flare composition.

4. CONCLUSION

MRL have examined a number of cartridges, illuminating, 1-1/2 inch J Mark 4T from lot 013 CY8/78. The results of this examination suggest that the cartridges are not serviceable due to the reduction of the free magnesium content in the pyrotechnic flare composition. The boxes containing the cartridges are dangerously pressurized with a mixture of hydrogen and probably ammonia gases.

5. ACKNOWLEDGEMENTS

The assistance of Mr W. Bracken, NQAR Newington and Mrs S. Spencer of Explosives Research Group, MRL is gratefully acknowledged.

6. REFERENCES

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2. Cackett, J.C. (1965). "Monograph on Pyrotechnic Compositions", RARDE
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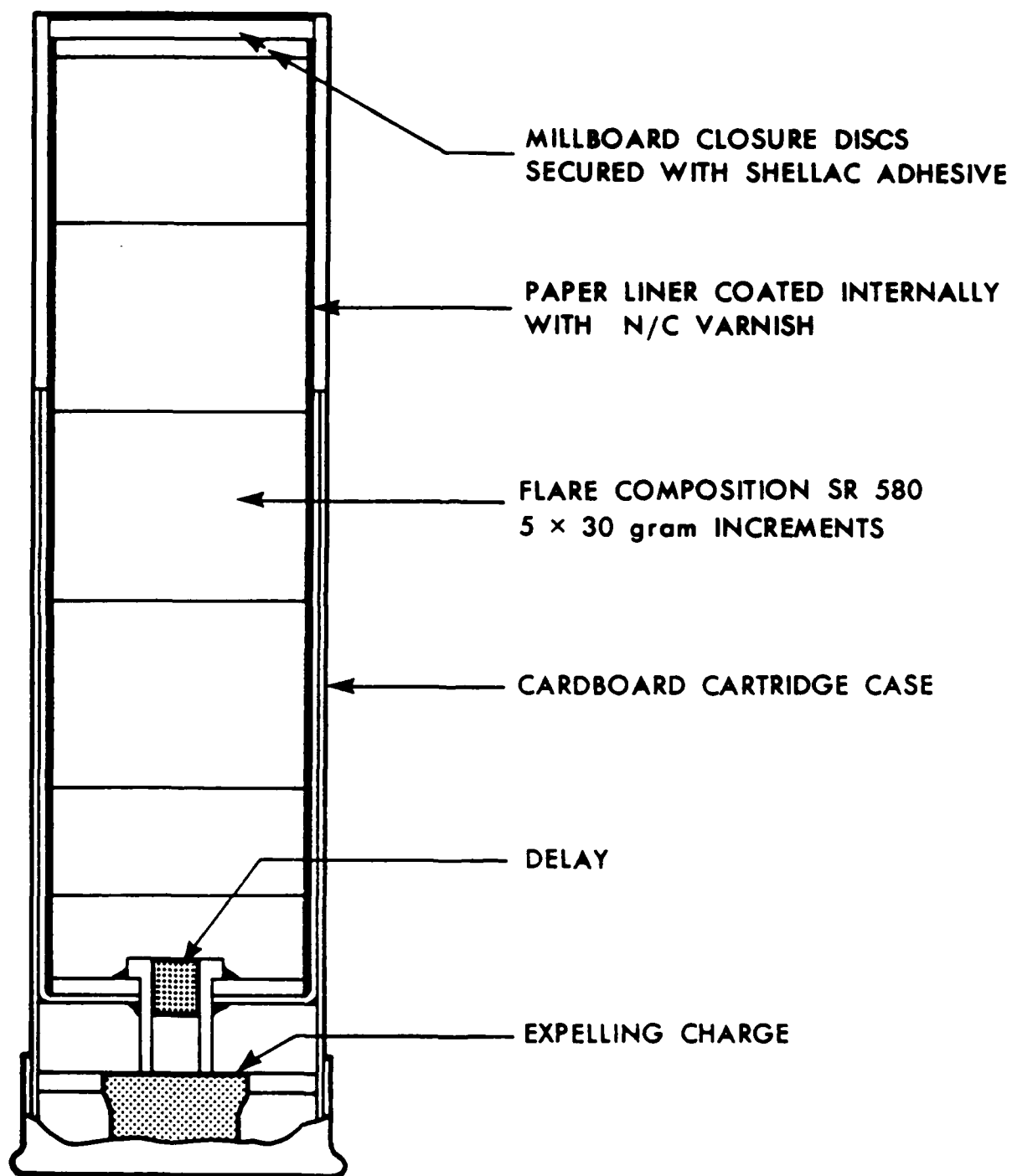
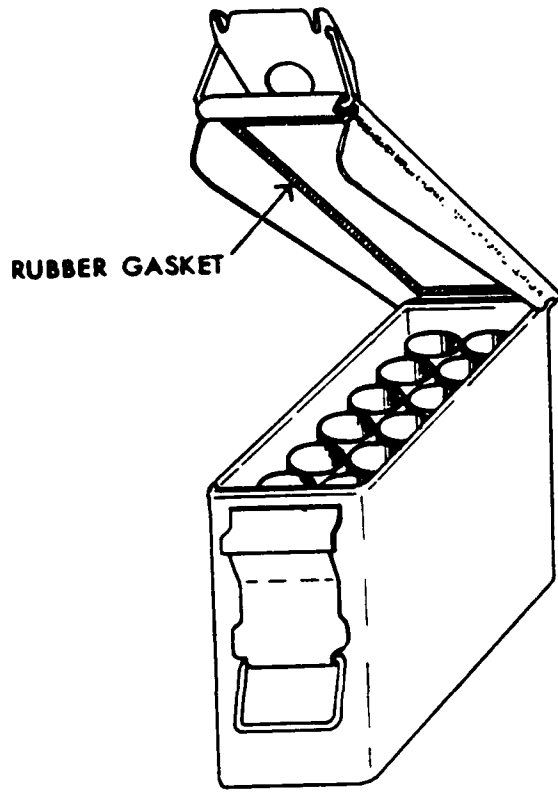
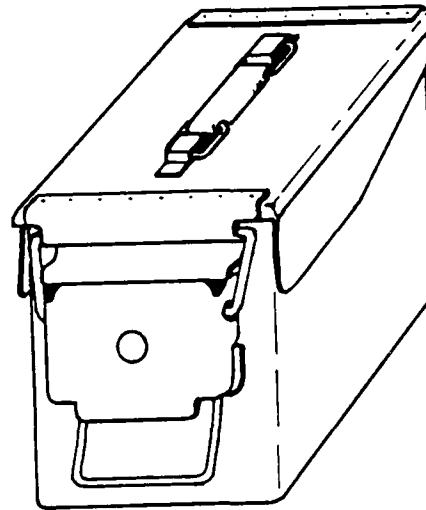


FIGURE 1 Cartridge Illuminating 1-1/2 inch J Mark 4T



M19A1



M2A1

FIGURE 2

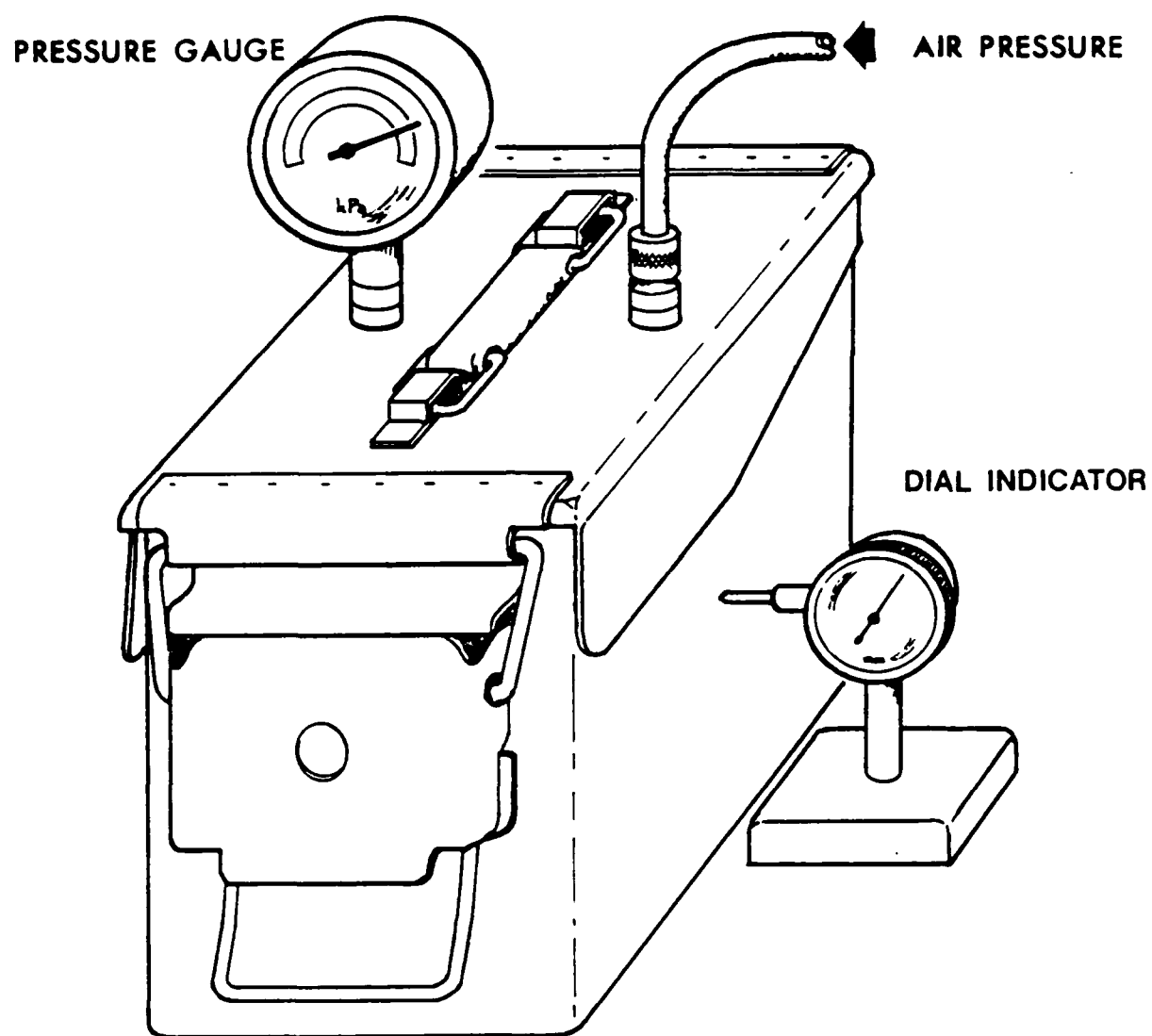


FIGURE 3

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